Unit 3 Assignment

[39 marks]

Making Connections [9 marks]

1. For the reaction, $A + 2B \rightarrow C + 3D$, the enthalpy of reaction is -90 kJ/mol and the forward activation energy is 48 kJ/mol.
   (a) Draw a completely labeled reaction profile for this reaction. [5 marks]
   (b) Label the Transition State. [1 mark]
   (c) Is this reaction exothermic or endothermic? [1 mark]
   (d) What is the value of the reverse activation energy? [2 marks]

Inquiry [27 marks]

2. Given the following information,

$2ClF_3(g) + 2NH_3(g) \rightarrow N_2(g) + 6HF(g) + Cl_{2(g)}$ $\quad \Delta H° = -1196$ kJ

$N_2H_4(l) + O_2(g) \rightarrow N_2(g) + 2H_2O(l)$ $\quad \Delta H° = -622$ kJ

$4NH_3(g) + 3O_2(g) \rightarrow 2N_2(g) + 6H_2O(l)$ $\quad \Delta H° = -1530$ kJ

determine the $\Delta H°$ for the following reaction

$3N_2H_4(l) + 4ClF_3(g) \rightarrow 3N_2(g) + 12HF(g) + 2Cl_2(g)$ [8 marks]

3. The exothermic reaction that occurs when a typical fat, glycerol trioleate, $C_{57}H_{104}O_6(s)$, is metabolized in the body is: $C_{57}H_{104}O_6(s) + 80\ O_2(g) \rightarrow 57\ CO_2(g) + 52\ H_2O(l)$. If 37.8 kJ is produced when 1.00 g of this fat is metabolized, calculate the molar enthalpy of formation of the fat in kJ/mol. Use your data tables. [10 marks]

4. The initial rate of a reaction $A + B \rightarrow C$ was measured for several different starting concentrations of A and B, with the results given below:

[A] (M)	[B] (M)	Initial Rate (M/s)
0.100	0.100	4.0×10^{-5}
0.200	0.100	4.0×10^{-5}
0.100	0.200	16.0×10^{-5}

(a) Determine the rate law for the reaction. Show your work. [3 marks]
(b) Determine the rate constant. [3 marks]
(c) Determine the rate of the reaction when [A] = 0.075 M and [B] = 0.050 M. [3 marks]

Knowledge & Understanding [3 marks]

5. Write the rate law for this reaction. Assume it involves a single elementary step. [3 marks]

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

Assignment

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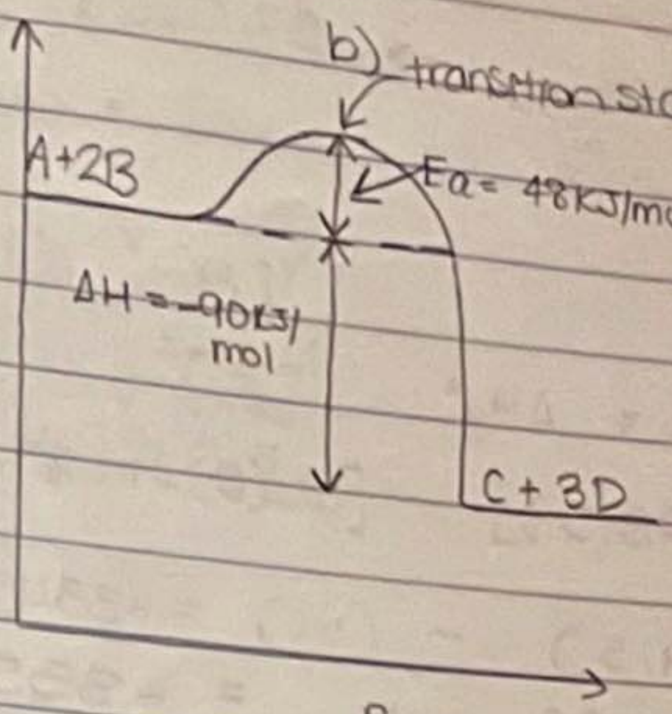
April 5/2018

1.

a)



c) the reaction is exothermic

(reverse)
d) Ea = 138KJ/mol
↳ 48KJ/mol + 90KJ/mol

9 MC

2. 8 I

(1) $4ClF_3(g) + 4NH_3(g) \rightarrow 2N_2(g) + 12HF(g) + 2Cl_2(g)$ $\Delta H = 2392$ KJ

(2) $3N_2H_4(l) + 3O_2(g) \rightarrow 3N_2(g) + 6H_2O(l)$ $\Delta H = -1866$ KJ

(3) $6H_2O(l) + 2N_2(g) \rightarrow 3O_2(g) + 4NH_3(g)$ $\Delta H = 1530$ KJ

$3N_2H_4(l) + 4ClF_3(g) \rightarrow 3N_2(g) + 12HF(g) + 2Cl_2(g)$ $\Delta H = -728$ KJ

3. $q = 37.8$ KJ

$m = 1.00$ g

$M = 885.44916$ g/mol

$n = \frac{m}{M}$

$= \frac{1.00\text{ g}}{885.44916\text{ g/mol}}$

$= 0.00112937$ mol

$= 0.00113$ mol

$\Delta H = \frac{q}{n}$

$\Delta H = \frac{37.8\text{ KJ}}{0.00113\text{ mol}}$

$\Delta H = -33451.32 \frac{\text{KJ}}{\text{mol}}$

$= -33500$ KJ/mol

$C_{57}H_{104}O_6(s) + 80O_2(g) \rightarrow 57CO_2(g) + 52H_2O(l)$

ΔH_f° ? 0 -393.5 -285.85

Rest is on Back →

$C_{57}H_{104}O_{6(s)} + 80O_{2(g)} \rightarrow 57CO_{2(g)} + 52H_2O_{(l)}$

Let x be the ΔH of $C_{57}H_{104}O_6$

$\Sigma \Delta H_f^\circ (P) = \Sigma \Delta H_f^\circ (R) = \Delta H_f^\circ$

$[52(-285,85) + 57(-393,5)] - [80(0) + x] = -33451,32$

10 I

$(-14864,2 - 22429,5) - (x) = -33451,32$

$-37293 - x = -33500$

$-3823 \frac{kJ}{mol} = x$

4. a) $r = K[A]^x[B]^y$

$r = K[A]^0[B]^2$ → $r = K[B]^2$

$A \rightarrow 2^x = 1$ ↳ 0th order

$B \rightarrow 2^x = 4$ ↳ 2nd order

b) using info for trial #2:

$r = K[A]^\circ[B]^2$

$4.0 \times 10^{-5} = K[\cancel{0.200}^{1}]^\circ [0,100]^2$

$\frac{4.0 \times 10^{-5}}{0.01} = K$

$0.004 = K$

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$4.0 \times 10^{-3} \; Ms^{-1}s^{-1} = K$

c) $r = 0.004[\cancel{0.075}^{1}]^\circ [0.050]^2$

$r = 0.00001$

$r = 1.0 \times 10^{-5} \; Ms^{-1}$ not based on units above

Qu:

Assignment

5. $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$

$r = K[A]^x[B]^y$

2

3 KM

$r = K[H_2]^2[O_2]^1$

$r = K[H_2]^2[O_2]$

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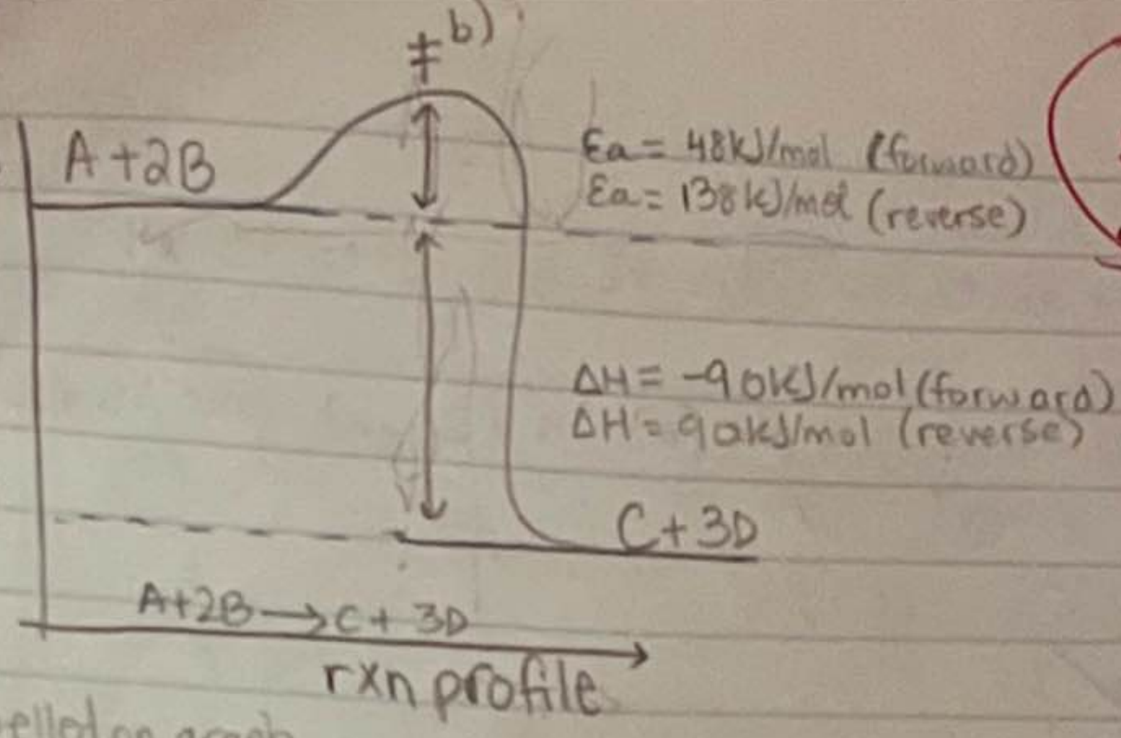
9
MC

1a) Ep



b) labelled on graph
c) exothermic
d) 138kJ/mol (48kJ/mol + 90kJ/mol)

8 I

2) $4ClF_3 + 4NH_3 \rightarrow 2N_2 + 12HF + 2Cl$ $\Delta H = -2392kJ$
$3N_2H_4 + 3O_2 \rightarrow 3N_2 + 6H_2O$ $\Delta H = -1866kJ$
$6H_2O + 2N_2 \rightarrow 4NH_3 + 3O_2$ $\Delta H = 1530kJ$

$3N_2H_4(l) + 4ClF_3(g) \rightarrow 3N_2(g) + 12HF(g) + 2Cl(g)$
$\Delta H = -2728kJ$ ✓

3) $\Delta H = \frac{q}{n}$

$q = 37.8kJ$
$n = ?$
$m = 1.00g$
$M = 885.44916\ g/mol$
$n = \frac{m}{M} = \frac{1.00}{885.44916} = 0.00112937mol = 0.00113mol$ ✓

9/10 I $\Delta H = \frac{q}{n} = \frac{37.8kJ}{0.00113mol} = -33451.32kJ/mol$ ✓

$C_{57}H_{104}O_6 + 80O_2 \rightarrow 57CO_2 + 52H_2O$
$x\ kJ/mol$ $0kJ/mol$ $-393.5\ kJ/mol$ $-285.8\ kJ/mol$

$\Sigma \Delta H_f^\circ(P) - \Sigma \Delta H_f^\circ(R) = 33451.32$
$[(-393.5)(57) + (52)(-285.8)] - [x + (80)(0)] = 33451.32$
$[(-22429.5) + (-14861.6)] - [x] = 33451.32$
$-37291.1 - x = 33451.32$
$x = -70742.42\ kJ/mol$. ∴, the ΔH_f° of $C_{57}H_{104}O_6$ is $-70742.4\ kJ$

Hilroy

4) a) $r = k[A]^x[B]^y$

Hold [A] constant at 0.100 M. [B] is x2 and rate is x4

$2^y = 4$, $y = 2$

Hold [B] constant at 0.100M. [A] is x2 and rate is x1

$2^x = 1$, $x = 0$

$r = K[A]^0[B]^2$

$\boxed{r = K[B]^2}$ ✓

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b) Substitution: $4.0 \times 10^{-5} = K[0.100]^2$

$\boxed{K = 0.004\ s^{-1}} \rightarrow \boxed{4.0 \times 10^{-2}\ s^{-1}}$ $M^{-1}s^{-1}$

c) $r = 0.004[0.075]^0[0.050]^2$

$r = 0.00001 \rightarrow \boxed{1.0 \times 10^{-5}\ M/s}$ Ms^{-1} not w/ these units

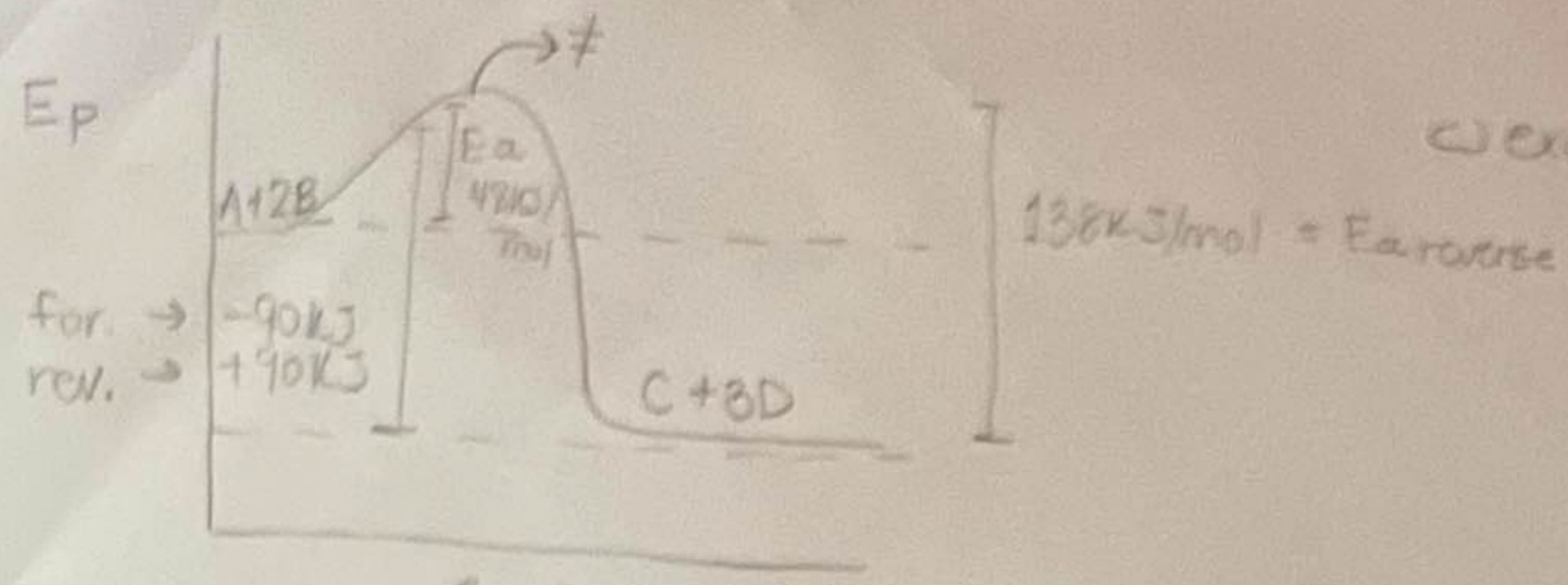
3 KMS) $r = K[H_2]^2[O_2]^1$

1. $A + 2B \rightarrow C + 3D$

$\Delta H = -90\,kJ/mol$

Activation energy $= 48\,kJ/mol$

✓ a)



c) exothermic d) 138kJ/mol

✓ 2. Already done

3 ✓ $A + B \rightarrow C$ a) $r = K[A]^1[B]^2$ $r = K[A][B]^2$ → 3rd order

b) $r = K[A]^0[B]^2$ $r = K[B]^2$ → 2nd order

$4.0 \times 10^{-5} = K[0.100]^2$

$0.004 = K$

$4.0 \times 10^{-3}\ M^{-1}s^{-1}$

✓ 4. $r = K[H_2]^2[O_2]^1$

Assignment

(1) $2ClF_{3(g)} + 2NH_{3(g)} \rightarrow N_{2(g)} + 6HF_{(g)} + Cl_{2(g)}$ $\Delta H = -1196\,kJ$

(2) $N_2H_{4(l)} + O_{2(g)} \rightarrow N_{2(g)} + 2H_2O_{(l)}$ $\Delta H = -622\,kJ$

(3) $4NH_{3(g)} + 3O_{2(g)} \rightarrow 2N_{2(g)} + 6H_2O_{(l)}$ $\Delta H = -1530\,kJ$

GOAL: $3N_2H_{4(l)} + 4ClF_{3(g)} \rightarrow 3N_{2(g)} + 12HF_{(g)} + 2Cl_{2(g)}$

(R) $3N_2H_{4(l)} + 3O_{2(g)} \rightarrow 3N_{2(g)} + 6H_2O_{(l)}$ $\Delta H = -1866\,kJ$

(1) $4ClF_{3(g)} + 4NH_{3(g)} \rightarrow 2N_{2(g)} + 12HF_{(g)} + 2Cl_{2(g)}$ $\Delta H = -2392\,kJ$

(3) $6H_2O_{(l)} + 2N_{2(g)} \rightarrow 3O_{2(g)} + 4NH_{3(g)}$ $\Delta H = 1530\,kJ$

Done and $\Delta H = -2728\,kJ$